Refer to: McConnell RY, Fox RT: Experience with percutaneous internal jugular-innominate vein catheterization. Calif Med 117:1-6, Aug 1972

California Medicine
THE WESTERN JOURNAL OF MEDICINE

Experience with Percutaneous Internal Jugular-Innominate Vein Catheterization

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■ *A specific technique of cannulation of the internal jugular innominate vein, presented herein, is not considered an innocuous procedure, but the incidence of serious complications is very low. In this technique a needle-in-catheter unit aids greatly in advancing the catheter through the vein. More than 62 percent of the catheters were left in place for more than five days. There was an 11.4 percent incidence of positive bacterial or fungal cultures from the catheter tip. Routine follow-up chest x-ray films demonstrated all the catheters in the innominate-superior vena cava venous system.*

IN THE AGGRESSIVE AND successful management of seriously ill surgical and medical patients, central venous cannulation is often indicated.[1-8] In each of the "indications" requiring fluid replacement, the central venous pressure may be monitored serially, thus insuring adequate volume replacement without over-loading.[9-12] Therefore, a number of techniques for placement of a catheter in the central venous system have been described and reviewed in the past.[12-18]

With the growing interest and recognition of the usefulness of central venous pressure (CVP) monitoring, a reliable technique of placing a catheter tip near or in the right atrium is now both useful and important.[1,3,16] The indications for measurement of the CVP have been well elaborated and the interpretation of serial readings discussed in detail.[19-24]

This paper reviews our experience with a specific technique of internal jugular-innominate vein cannulation.

Methods

During the nine-month period from August 1970 through April 1971, percutaneous internal jugular-innominate vein cannulation was performed 371 times on 357 seriously ill patients at the Memorial Hospital Medical Center of Long Beach, Long Beach, California. Of the total number of patients, 306 were on the surgical services and 51 on the medical services (Table 1).

All of the cannulation attempts included in the study series were carried out by one or the other of the authors. In this way there was guaranteed consistency in technique. In most cases catheterization was an elective procedure and sterile technique was employed. When the procedure was done in emergency, it was most often on patients in cardiopulmonary arrest.

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Submitted, revised, November 2, 1971.

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TABLE 1.—*Primary Indications for Central Venous Cannulation in 371 Procedures*

Indications	*Number*
Cardiopulmonary arrest	31
Parenteral hyperalimentation	43
Severe burns	1
Prior to major surgery in high-risk patients	11
Immediate post-operative cardiovascular instability	33
Acute circulatory failure, excluding patients in the first 24 hours post-op.	63
Unable to cannulate a peripheral vein or perform venipuncture	59
Severe oliguria or anuria	6
Massive fluid replacement	113
Phlebotomy	11
Total Catheterizations	371

Seventy consecutive patients (the 210th to the 279th) were studied to evaluate the infectious complications of this procedure. Cultures were obtained from the skin around the catheter and the distal 2 cm tip of the catheter. The skin was prepared with an iodine and alcohol preparation before the catheter was removed.

Seventy consecutive patients (catheterization 185th to 254th) were studied with chest radiographs following injection of a solution of 60 percent meglumine iothalamate (Conray®-60), a radiopaque dye, to delineate the contour and the extent of the catheter.[25]

Technique

In this approach to catheterization, the right side of the neck is preferred because the dome of the right lung is lower, there is a more or less straight line to the right atrium, and the thoracic duct is not in the way. The most important anatomical points to remember are that the internal jugular vein is anterolateral to the common carotid artery and "ends behind the medial edge of the clavicular head of the sternocleidomastoid muscle just above the medial end of the clavicle."[26,27]

The procedure is most easily performed with the patient supine and his feet elevated 15 to 20 degrees, or in a 15 to 20 degree Trendelenberg position. The patient's head is rotated only slightly to the left (hyper-rotation will distort the anatomy of the neck). The anterior neck between the mandible and the clavicle is cleansed with tinture of Zephirin® 1:750, and sterile towels are placed.

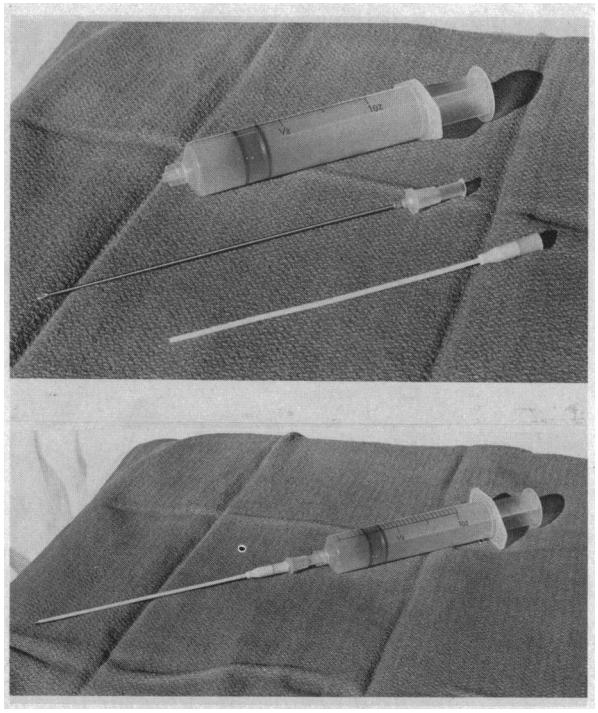

Figure 1.—*Above*, The Angiocath unit 14 gauge, 5¼ inches long) unassembled, and a large plastic syringe. *Below*, the unit assembled and attached to the plastic syringe ready for use.

The correct identification of the area of insertion is important to the success of this procedure. This point is located 4 cm above and 2 cm lateral to the suprasternal notch of Burns. This also locates the point of insertion in the apex of the triangle formed by the clavicle and the sternal and clavicular heads of the sternocleidomastoid muscle. A 25 gauge needle is used to infiltrate lidocaine (Xylocaine®) in the skin and the proposed needle tract.

We have used exclusively the 14 gauge, 5¼ inch Deseret Angiocath unit for the catheterization (Figure 1). Attaching a large plastic syringe (20 or 30 ml) with a luer tip to the needle-in-catheter unit provides better control of the needle, and the tight seal with the needle prevents air from entering the venous system during respiratory excursion. With the unit assembled as in Figure 1, the skin is penetrated and the needle is then carefully directed at an angle 35 to 40 degrees posterior to the coronal plane of the body and parallel to the saggital plane of the body (Figure 2). Next it is slowly advanced through the deep cervical fascia with negative pressure in the syringe. The needle is withdrawn to the skin surface should any of the following occur:

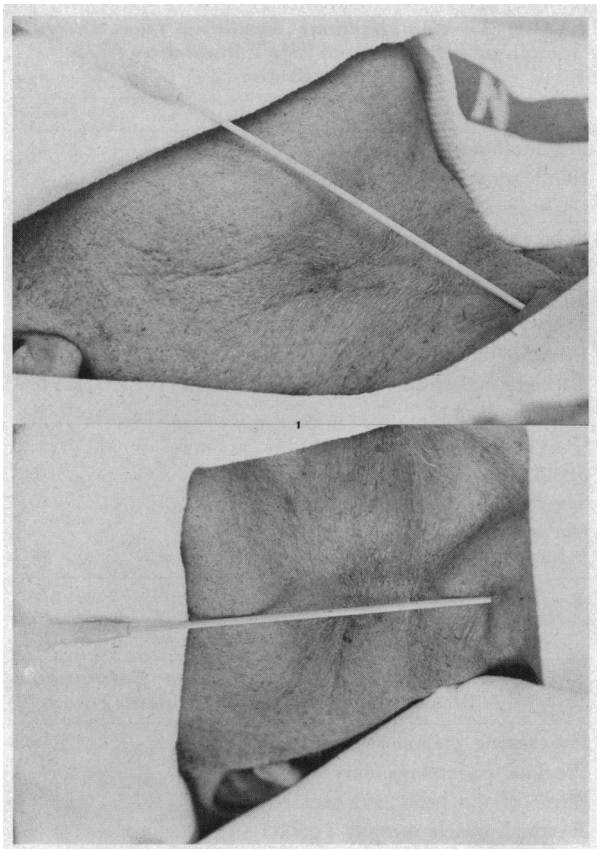

Figure 2.—*Above*, A lateral view of the right side of the neck, showing the needle-through-catheter unit 35 degrees to the coronal plane of the body. *Below*, a view from above the anterior neck region, with the needle-through-catheter unit parallel to the saggital plane of the body.

pulsation felt against the catheter tip or the return of bright red pulsatile blood; 2-inch advancement without blood return; aspiration of air; inability to advance the needle. During the second attempt at advancement, the tip of the needle should be directed 10 degrees laterally.

After the vein is penetrated, a free flow of blood will enter the syringe. Without changing the position of the needle, the catheter is advanced along the needle (Figure 3). Any difficulty in advancing the catheter is probably because it is lodged against the posterior wall of the vein. This can be alleviated by changing the previous 35 to 40 degree angle with the coronal plane to 10 to 15 degrees, and then proceeding with the advance. After the catheter has been advanced, the needle is removed and the syringe is attached to the catheter in order to recheck for blood return. Care must be taken to cover with the gloved finger the open end of the catheter when disconnected in order to prevent air embolus.[28] The catheter is then connected to tubing ready for infusion (Figure 4).

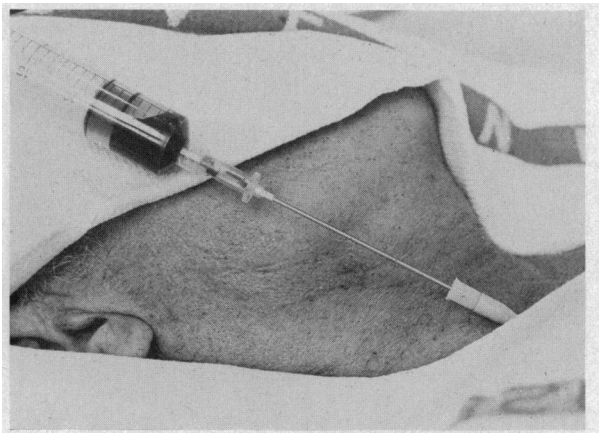

Figure 3.—Free aspiration of blood, and the catheter advanced along the needle.

The catheter is fixed to the skin at a point 2 cm from the insertion site with a No. 4-0 silk suture. A topical bacteriostatic agent as an ointment (Neosporin®) is applied locally and a small sterile dressing is placed over it and taped securely. The dressing is changed every other day and the bacteriostatic agent is reapplied at the time of change.

Results

This series demonstrates a variety of possible dangers inherent in percutaneous placement of an internal jugular vein catheter (Table 2). Pneumothorax occurred in four patients. In one patient a 50 to 60 percent tension type pneumothorax occurred and was treated with closed thoracotomy tube drainage without difficulty. In three patients simple pneumothorax of 15 percent or less was shown on x-ray films of the chest but the air resorbed spontaneously. Hydrothorax occurred in one patient in whom the catheter penetrated the posterior wall of the vein and fluid infused into the pleural space. Puncture of the common carotid occurred in eight patients, but application of 5 to 10 minutes of direct pressure stopped the bleeding. In an elderly patient with a tortuous, laterally displaced common carotid artery, puncture can be avoided by pressing the vessel with the middle and index fingers to displace it medically.[18]

In 23 percent of the patients in this series there were abnormal conditions that made cannulation by the technique we described less easy or caused

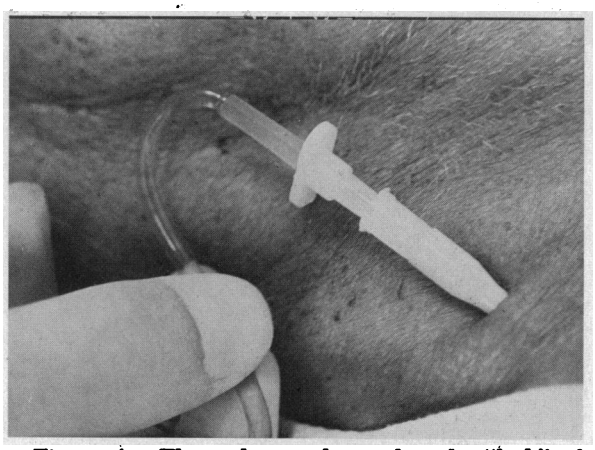

Figure 4.—The catheter advanced to the "hub" of the unit, the needle-core removed, and the tubing connected for infusion.

concern about the possibility of complications (Table 3). Four of the patients had had unilateral pneumonectomy in the past and in three others there was pre-existing pneumothorax. In these cases catheterization was successfully accomplished after radiological and physical examination to determine whether there was significant tracheal or mediastinal deviation. In 36 cases severe obesity (weight over 250 pounds in a man, over 200 pounds in a woman) obliterated certain landmarks of the two heads of the sternocleidomastoid muscle. Tracheostomy in nine patients not only distorted the surface anatomy but so limited the area for securing the dressing that the possibility of contamination and local infection was somewhat enhanced. Twenty-seven patients were receiving anticoagulant agents, but no significant subcutaneous or internal bleeding occurred. One patient with residual muscle atrophy of the right shoulder girdle and arm from poliomyelitis and a past history of a fractured clavicle had severe distortion of the anatomy of the area. It was in that case that the catheterization attempt resulted in the 50 to 60 percent pneumothorax mentioned above.

The catheters were left in place for a relatively long time—for periods of more than five days in 62 percent of cases, and in 6 percent for more than 21 days (Table 4).

Aerobic and anaerobic bacterial and fungal cultures of material from the catheter tip were obtained from 70 consecutive patients. They were positive for organisms in eight cases (Table 5). In those cases the average length of time the catheter was kept in place was 15.6 days, with a range of 4 to 32 days. In Cases 2, 4, and 5 (Table 5) the patients were receiving parenteral hyperalimentation. Candida albicans was cultured from all three. Only in Case 2 was the patient

TABLE 2.—*Complications Resulting from Internal Jugular Innominate Vein Cannulation (371 Catheterizations)*

Complications	*Number*
Pneumothorax	4
Hemothorax	0
Hydrothorax	1
Subcutaneous hematoma and/or infiltration	5
Mediastinal infiltration	0
Subcutaneous emphysema	0
Common carotid artery puncture	8
Brachial plexus injury	0
Catheter embolism	0
Air embolism	0
Cellulitis (local)	1
Septicemia	0
Severe phlebitis	0
Occlusion of jugular, subclavian, or innominate vein	0
TOTAL	19

TABLE 3.—*Hindering Circumstances Encountered (371 Catheterizations—357 Patients)*

Pre-existing pneumothorax	3
Previous pneumonectomy	4
Burns of the head and neck	1
Residual muscle atrophy (polio) and previous clavicular fracture	1
Anticoagulants	27
Tracheostomy	9
Severe obesity (men over 250 lbs., women over 200 lbs.)	36
TOTAL	81

TABLE 4.—*Length of Time Catheter Was Left in Place (Excluding 16 Unsuccessful Cardiopulmonary Resuscitations)*

Duration	*Number*	*Percent*
Less than 6 hours	4	1
6 to 24 hours	20	6
24 to 48 hours	10	3
48 to 72 hours	14	4
72 to 96 hours	26	7
96 to 120 hours	61	17
5 to 7 days	101	28
7 to 14 days	56	16
14 to 21 days	43	12
Over 21 days	20	6
TOTAL	355	100

TABLE 5.—*Results of Culture (70 Consecutive Patients)*

Case	Organism	Catheter	Skin	Catheter in place (days)	Other Site Positive
1	Klebsiella sp.	+	+	6	Tracheostomy
2	Candida albicans	+	+	32	Urine, blood
3	Enterobacter	+	−	4	Abdominal wound
4	Candida albicans	+	+	29	None
5	Candida albicans	+	+	18	None
6	Yeast (unidentified)	+	+	16	None
7	Staphylococcus albus	+	+	6	None
8	Staphylococcus aureus (+)	+	+	14	None

febrile, but the temperature returned to normal within 24 hours after removal of the catheter. In Case 3 the catheter was placed during cardiopulmonary arrest. Enterobacter organisms were cultured from both a surgical abdominal wound and the catheter tip but blood cultures were negative. In Cases 6, 7, and 8 the catheter was placed by sterile technique; none of the patients were febrile, and all the blood cultures were negative.

In the previously mentioned chest x-ray studies in 70 consecutive cases, none of the catheters was found to be extending into the ipsilateral subclavian vein or the contralateral innominate vein, or penetrating outside the vein or curling and kinking back upon itself.

Comment

Of the alternate methods of placing central venous catheters, Craig et al[16] found the subclavian route was the most successful, but studies by Yoffa,[2] Smith,[29] Matz,[30] and Schapira[31] called attention to multiple associated serious complications and failures. Bradley[32] considered the use of the saphenous vein or femoral vein inadvisable if there is any suggestion of thromboembolic disease, and Landis et al[33] discussed the complications of in-dwelling catheters in the inferior vena cava. We believe the internal jugular innominate vein technique is more dependable with fewer complications, but a specific routine, a knowledge and appreciation of the anatomy and an awareness of the possible complications are important. Bernard and Stahl[34] showed that complications from subclavian venipuncture are directly related to the experience of the person performing the procedure. But even with experience some complications, probably related to anatomical variations, are inevitable.

Bernard, Stahl, and Chase[35] very adequately reviewed the literature on the infectious complications of venous catheters. In their own series of subclavian catheterization, there was a 39.8 percent incidence of positive culture of the catheter tip.

In our series the incidence of positive cultures of the catheter tip was 11.4 percent. Cultures of Candida albicans were obtained from three of 17 patients (17.6 percent) who had been receiving parenteral hyperalimentation for an average of 26 days. Every two to three days the dressing was changed, the skin about the site of insertion was cleansed, and bacteriostatic antibiotic ointment was apparently applied aseptically. In each of the three cases the catheter acted as a nidus of infection of fungal organisms from the skin. This data supports the suggestion by Bernard et al[35] that a fungistatic agent be added to the antibiotic ointment.

Since high blood flow around the catheter favors long-term sterility, Wilmore and Dudrick[8] advocate the placement of catheters in large lumen central veins rather than in peripheral vessels.

The greatest advantages of the technique as described here are: The landmarks of the point and angle of insertion of the catheter are readily located; the catheter is advanced along the needle into the vein without need to disconnect the syringe; the strength of the catheter decreases the possibility of kinking and curling; the length of the catheter (5¼ inches) is such that it can be inserted up to its hub, thus eliminating guesswork as to how far to advance it; and "maintenance of long-term sterility is favored by high blood flow around the catheter."[8]

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Xylocaine® Hydrochloride .....lidocaine hydrochloride
Neosporin® Ointment ....polymyxin-bacitracin-neomycin
Conray®-60 .....meglumine iothalamate, 60%

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MECHANICAL VENTILATION IN OBSTRUCTIVE LUNG DISEASE

What are your indications for mechanical ventilation in patients with acute-on-chronic obstructive lung disease?

First of all, is the patient an emergency? Has the patient been allowed to go above 90 mm of mercury on uncontrolled oxygen therapy? If the P_{CO_2} is above 90 and you remove oxygen even for a very short time, the patient will die because his arterial oxygen will drop into that very low level. If the P_{CO_2} has been allowed to go very high, the patient obviously must be ventilated. On the other hand, if the patient has a P_{CO_2} which rises over the course of an hour or two to 80 or 90 mm of mercury on controlled oxygen and if at the same time he becomes more drowsy and unable to cough and if all our conservative measures of suction, physiotherapy, and general encouragement fail, then we put him on the ventilator.

Finally the third indication—if we have given the patient controlled oxygen therapy and failed to keep his P_{O_2} well above 30, then we may well consider ventilation at an earlier stage. But we would not ventilate any patient who was virtually confined to bed or confined to the house beween attacks. And we try and direct our attention to the patient who has some possibility of getting back to a useful existence after attacks.

—M. KEITH SYKES, M.D., London

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